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NOTES ON THE IDENTIFICATION OF THE CHÆTOGNATHA.

E. LE ROY MICHAEL.

INTRODUCTORY REMARKS.

It is the testimony of all, who have attempted the identification of the Chætognatha, that, for so small a group, they offer an immense amount of difficulty. The several species are very similar in appearance so that one is compelled to seek among details of structure for valid taxonomic characters. There is, moreover, considerable variation in most of the characters ; some of the valuable diagnostic features are readily destroyed even with the best possible preservation, and the methods of microscopical technique, usually so efficient, fail, for the most part, with the Chætognatha. It is not surprising then, that, without most careful examination, it becomes easy to base identifications on abnormalities or upon too variable characters. This has been repeatedly done by the earlier investigators with the result that the various species have become so entangled in the literature that, for anyone not a specialist on the group, identification is well nigh an impossible task. To meet this need for an adequate and ready means of identification the keys and tables herein presented have been prepared.

Except in the papers of Fowler ('05, '06), Hertwig ('80), and Krumbach ('03) identification has been based upon characters having little or no taxonomic value. Hertwig's investigations are clear and to the point but, unfortunately, only a few species came under his observations. Krumbach has accurately made a detailed study of the seizing jaws and has developed a classification based upon the minute anatomy of these structures. It is an exceedingly valuable contribution for, in many cases of poor preservation, these hard structures offer the only means of identification. There is, however, one difficulty with the Krumbach system : it requires so minute an examination that it is only after one has worked at it for some time that he is able to see the distinctive

features with certainty. Fowler's papers, accurate and careful in most details, offer, by far, the best aid to the systematist. The characters used are carefully chosen and tested by an examination of a large series of individuals of each species. Anyone attempting to work on this group will find both the Biscayan and Siboga Reports of this investigator invaluable.

In the genus *Sagitta* I have adopted the synonymy of Fowler ('06), who recognizes eighteen valid species, as shown in the table at the close of this paper. In addition there are several doubtful species: *Sagitta hispida* Conant, *S. tenuis* Conant, *S. maxima* Conant, *S. bedfordi* Doncaster, *S. septata* Doncaster, *S. elegans* Verrill, and *S. arctica* Aurivillius. Descriptions of these species have been so incomplete and drawings so few that, upon the available data, it is impossible to determine their validity. *S. arctica* is very possibly a synonym for *S. elegans* but, until the original specimens can be redescribed, it is best to leave them in the category of doubtful species. Of all the doubtful species Verrill's *S. elegans* appears to be the most valid, but so little is defined in the description that it will not be included in this paper.

Of the eighteen species only a few have, as yet, been found in American waters. *Sagitta hexaptera*, *S. enflata*, and the doubtful species *S. elegans*, *S. tenuis*, *S. maxima*, and *S. hispida* have been recorded from the Atlantic Coast, by Conant ('95, '96), Verrill ('83), and Stevens ('05). The genus *Spadella* is represented by two species, *Spadella draco*, and the doubtful *S. schizoptera* Conant. *Krohnia* is represented by the single species *Krohnia hamata*. The collections of the University of California from the San Diego region of the Pacific Coast, examined by me, contain the following species of *Sagitta*: *Sagitta serratodentata*, *S. zetesios*, *S. enflata*, *S. hexaptera*, *S. bipunctata*, *S. furcata*, *S. neglecta*, *S. decipiens*, and *S. pulchra*. *Spadella* is represented by the single species *Spadella draco*, only one individual having been taken. *Krohnia* has not, as yet, been recorded.

Most of the material, which I have examined, consists of a large number of specimens obtained from the coast of Southern California by the explorations of the San Diego Marine Biological Laboratory, and from the collections made by the "Albatross" in the explorations of the United States Bureau of Fisheries on

the coast of California in 1904. The method has been to separate the material into three assortments, according as the preservation was excellent, fair, or poor. A large series from each assortment was examined in an attempt to isolate the taxonomic characters, and the results from each individual specimen tabulated. Proceeding on this basis I am in a position to utilize, in all essentials, the characters Fowler ('05, '06) has chosen. In the ensuing pages frequent use will be made of his reports.

METHODS OF PRESERVATION.

Killing has been tried with various combinations of acids, alcohol, and formalin, but, of all reagents, weak formalin gives, by far, the best results. Other reagents cause unequal contractions, swellings, and gross distortions, thereby ruining the material. Fowler ('05) advises killing separately in weak formalin then, after a short time, transferring them, for permanent preservation, into from 5 to 10 per cent. On the whole this method gives excellent results but I have found, in some cases, that considerable curling results. Specimens in this condition are difficult to handle and measurements are rendered more or less inaccurate. The following method will overcome this curling and otherwise give most perfect results: Each *Sagitta* is placed separately on a dry slide or cover-glass and allowed to remain exposed to the air for several seconds. This causes the animal to stick slightly to the slide. Then hold the slide in a vertical position and apply formalin (5 to 10 per cent.) at the upper end, allowing it to wash over the animal which will be killed before it has time to loosen itself from the slide. Another method of adding formalin, drop by drop, to a jar of *Sagitta* has given excellent results, but, if the formalin is added too fast, the results are uneven, owing to variability in the activity of the individuals, some contracting violently to a very weak solution while others are apparently unaffected by it. The three methods herein stated are all good; the second takes the most time but produces the surest results.

METHOD OF MEASUREMENT.

Fowler ('05) advises camera drawings as measurements otherwise taken are frequently erroneous, in many cases not tallying

with the drawings at all. For the general features of the body the camera is necessary, but some measurements are so difficult to discern that one is never quite sure he is tracing correctly. I have found it extremely difficult, in such species as *Sagitta enflata*, to see the cephalic limits of the anterior fin, and have never been able to trace the outline with certainty. I find that an ocular micrometer gives more certain results, with such measurements, than the camera.

CHARACTERS USED IN CLASSIFICATION.

The internal organs of *Sagitta* consist of the digestive, reproductive, and nervous systems. The first includes a simple straight tube leading from the mouth to the anus and offers no definable diagnostic characters; the two lateral diverticula, used by several writers, would seem to be not real diverticula, but rather results of extreme contraction of the head at death. The size and shape of the vesiculæ seminales depend entirely upon the sexual condition of the animal at the time of capture. The extension of the ovaries varies in the different species but, as they are the last organs to develop, one may find an otherwise mature *Sagitta* with ovaries of any length up to the specific maximum. The shape of the ovaries, whether long and slender, or short and thick, possibly has some significance, but as the length depends largely upon the extent of growth, and the width largely upon the maturity of the ova, too much weight cannot be placed upon these characters. The ova might possibly offer excellent characters for diagnosis, but with our present knowledge, one can never be sure whether they are mature or not. The nervous system, if well worked out for every species, might offer excellent characters, but except for two or three species the nervous system has not been investigated. Should the most excellent characters be offered here, their adoption as a means of ready identification would be inconvenient, owing to the technical methods and delicate work required to bring out the points. We are, therefore, compelled to look to the external characters as our only means of accurate identification.

Even among the external features a few characters have been used in the past, which appear to be worthless for specific deter-

mination. The comparative size of the head would seem to be due to the extent to which contraction occurs at death; if the contraction be slight the head appears larger, if great it appears smaller. This also applies to a less extent to the presence or not of a neck but, allowing for the variation thus produced, it may have some taxonomic significance. Again, the presence or absence of color seems to vary with the individual rather than with the species. Fowler ('05) has obtained, in the same haul, individuals of the same species, some a salmon pink, and others without color. The shape of the fins, whether triangular or half elliptical, would be an excellent character were the fins not so frequently damaged. Fowler ('05) has obtained specimens with a triangular fin on one side which had been rubbed into an ellipse on the other. One is often still less certain, from evidence derived from preserved material, whether the tail fin is truncate or rounded in nature.

The structural features then, which are available for diagnosis, consist of the cephalic armature, musculature, lateral fields, corona ciliata, and proportional measurements of various regions of the body. The table, at the close of this paper, includes all valid taxonomic characters, a discussion of which follows.

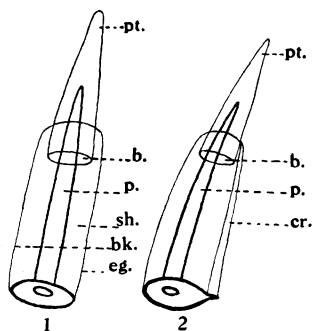
Prior to Krumbach's ('03) paper on "Die Greifhaken der Chaetognathen" practically the only use made, in classification, of the seizing jaws consisted of their enumeration and, even so, the tendency has been to describe the species on a basis of one or two individuals so that not enough latitude has been left for variation within the species. The number of seizing jaws is a very important matter and should be tabulated, together with the number of teeth and length of specimen, for a considerable number of individuals. When the number of seizing jaws is combined with their anatomical characters, as elaborated by Krumbach ('03), they present excellent criteria for identification, and, in many cases, where preservation is poor, practically the only safe criteria. Krumbach ('03) has defined the differences among the various species in the form and curvature of the seizing jaws, the presence and extent of a crest along the shaft, presence and nature of serrations, curvature and shape of the points, extent to which the point is inserted into the shaft, extent

of the pulp into the point, and the pattern of the pulp. Unfortunately all known species were not studied by Krumbach. His method should certainly be extended to the remaining species. His classification is here briefly summarized.

The nine species of Chætognatha studied by Krumbach ('03) were *Sagitta bipunctata*, *S. enflata*, *S. hexaptera*, *S. furcata*, *S. serratodentata*, *S. minima*, *Spadella draco*, *Krohnia hamata*, and *Sagitta magna*, the latter, according to Krumbach ('03), and Fowler ('06), probably being a variety of *S. hexaptera*. These several species Krumbach divides into four groups as follows :

GROUP 1 (Figs. 1 and 2).

Point *pt* with an oval base *b* : strongly needle-shaped. Pulp *p* extends along the central axis of the shaft. Upper third of shaft strongly bent. This group includes two species, *Sagitta bipunctata*, and *Spadella draco*.



Sagitta bipunctata (1).

Point *pt* imbedded one third its height into the shaft *sh*. Shaft with fine longitudinal furrows on the surfaces between the back *bk* and the edge *eg*.

Spadella draco (2).

Flat broad edged crest *cr* on edge of shaft. Point *pt* inserted one fourth to one fifth its height into shaft. Old jaws have serrations on the lower end of the shaft, which dwindle in size as they approach the point, disappearing entirely while still some distance from the point.

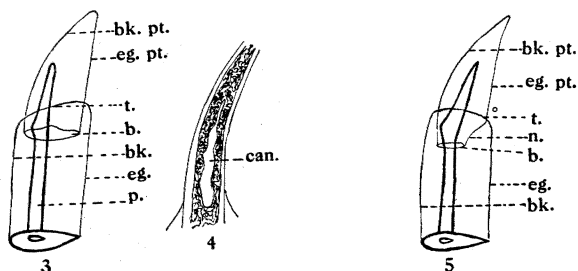
GROUP 2 (Figs. 3, 4 and 5).

Point *pt* with an oval base *b*. Back of point *bk.pt* has greater curvature than the back of the shaft *bk*; edge of point *eg.pt* and edge of shaft *eg* have the same curvature so that the junction of the back and edge of the point at the apex lies toward the edge. Pulp *p* runs slightly nearer the back of the shaft *bk*. Shaft evenly

and slightly curved. This group includes *Sagitta enflata* and *S. furcata*.

Sagitta furcata (3 and 4).

Base of point *b* and top of shaft *t* converge as they approach the back of the shaft *bk*. Cross-section of the shaft is a slender wedge-shape. Pulp *p* is displaced toward the back of the shaft



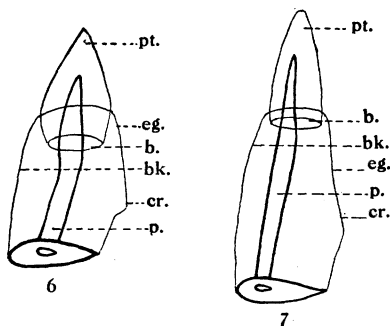
bk. Pulp *p* is concentrated around a canal *can*, which is of a cucumber form and extends to the upper third of the shaft. Old jaws with a small crest.

Sagitta enflata (5).

Base of point *b* and top of shaft *t* converge as they approach the edge of the shaft *eg*. Edge of point *eg. pt* near the base *b* is notched *n*. Cross-section of the shaft more of an oval than in *S. furcata*. Canal irregularly distributed through the pulp.

GROUP 3 (Figs. 6 and 7).

Point *pt* with a broad oval base *b*. Pulp *p* slightly toward back of the shaft *bk*. Base of point *b* makes a right

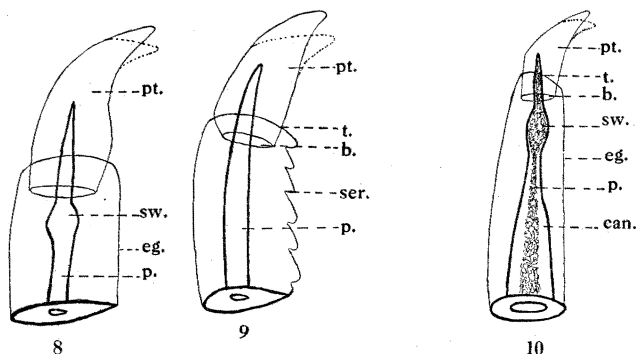


angle with the back of the shaft *bk*. Angle between base of point *b* and edge of shaft *eg* is acute. Shaft below point with a short massive crest *cr*. Edge of crest extends proximally on a line with the edge of the point for some distance and then makes an abrupt turn toward the shaft. Shaft evenly and strongly

curved. This group includes *Sagitta hexaptera* (6) and *S. magna* (7). The latter is, as previously mentioned, now regarded as a variety of *S. hexaptera*. The only difference is that the jaws of *S. magna* are finer, more slender, and delicate than in an individual of *S. hexaptera* of the same size. The pulp reaches higher toward the apex of the point than in *S. hexaptera*.

GROUP 4 (Figs. 8, 9 and 10).

Point *pt* sickle-shaped, bent toward the edge of the shaft *eg*, varying in curvature between the two extremes indicated. Base more or less oval. Pulp *p* enters the shaft between the center



and the back focus of the cross-section. Pulp reaches nearly to the knee of the point, but never makes the bend. Shaft only slightly curved. This group includes *Sagitta minima*, *S. serratodentata* and *Krohnia hamata*.

Sagitta minima (8).

Jaws slender and long with slender points only slightly set into the shaft. Cross-section of shaft wedge-shaped. Pulp *p* is swollen *sw* slightly below the point. Tip of point *pt* bent much more than the rest of the jaw. Old jaws have a small delicate crest.

Sagitta serratodentata (9).

Pronounced serrations *ser* on the shaft. The first tooth of the serration is the smallest, extending from the top of the shaft *t* half-way to the basal line of the point *b*. Proceeding proximally the teeth increase in size. Cross-section of the shaft is an

elongated wedge. Old jaws are supplied with a pronounced crest.

Krohnia hamata (10).

Jaws heavy with broad oval cross-section. Pulp *p* only scantily fills the center of the canal *can*. Pulp swollen *sw* as in *S. minima*. Base of point *b* and top of shaft *t* converge toward the edge of the shaft *eg*.

Taken in connection with the seizing jaws the teeth afford an excellent means of identification. Their arrangement into two pairs of rows distinguishes *Spadella* and *Sagitta* from *Krohnia*, which has but one. Within the genus *Sagitta* a glance at the table at the close of this paper will indicate the importance of mere number. It is advisable that the limits of variation for every length of individual be accurately known. Were this accomplished, by combining the number of anterior and posterior teeth with the length of individual, a criterion of identification would result of much value to the systematist.

The form and arrangement of the teeth, if properly recorded, will considerably assist in identification. Some teeth are slender, some broad, so that proportional measurements of width and length are desirable; the length of tooth should also be compared to the length of individual so as to define exactly what is meant by saying that the posterior teeth of *Sagitta hexaptera* are long and slender, while those of *S. ferox* are long and broad. In any group like the Chætognatha, where, at best, identification is difficult, we should endeavor to rid ourselves of characters based upon mere comparisons. All such characters may, at the expense of a little labor, be reduced to exact or proportional measurements. If one merely says that the posterior teeth of *Sagitta siboga* "are long, broader, and with narrower bases than in *bedoti*," anyone attempting to identify a *S. siboga* would wonder whether the teeth were absolutely broader, broader in proportion to the length of tooth, or broader in proportion to the length of individual.

The inclination of the teeth, whether upright, externally or internally oblique; the proximity of setting, whether close or distant, are of some importance. Fowler ('05, '06) has used

some of these characters but, as yet, they are in a comparative form lacking in that element of exactness and definition so necessary for accurate classification by one unfamiliar with the group.

Another important character is present in the vestibular ridge. The presence of high or low, numerous or few, blunt or acute papillæ are matters that need more attention in the future. The position and height of the papilla should be compared to the position and height of the tooth, and similarly their number should be compared to the number of teeth. Comparison of the extent of the ridge with that of the tooth row proves of some importance; whether it is longer or shorter than the tooth row, and if shorter how many teeth project beyond; whether it terminates abruptly or gradually, in a lateral process or not.

The fins offer good characters if the specimen is well preserved. The presence or absence of a second pair of lateral fins serves to distinguish between *Sagitta* and the other two genera. Relation of the anterior to the posterior fins in length and breadth has been found to be a useful character. In *Sagitta hexaptera*, *S. macrocephala*, *S. neglecta*, *S. bipunctata*, *S. robusta*, *S. serratodentata*, and *S. planctonis* the posterior fin is longer than the anterior fin; in *Sagitta ferox*, *S. pulchra*, *S. zetesios*, *S. whartoni*, and *S. siboga* the posterior fin is shorter; in *Sagitta bedoti*, *S. enflata*, *S. regularis*, *S. furcata*, and *S. decipiens* both fins are the same length. Here again, it is necessary to know how much variation to allow for those in the third group, and to accurately determine this requires measurements of a large series of individuals of each species.

The distance from the anterior to the posterior fin, as measured in per cent. of the total length of the individual, may be made of considerable service. From the table we see that, in *Sagitta bedoti*, this distance measures but 5.4 per cent., the least I have found, except in the case of *Sagitta whartoni* where the fins are confluent, while *S. siboga* measures approximately 15 per cent. The other species are distributed between these extremes. While the measurements are not extensive enough to be of much value, still we can separate the species into two groups; those in which this interval is more than eight per cent. and those in which it is less than eight per cent. In making this separation we still

allow sufficient variation to feel quite safe, except in the case of *Sagitta bipunctata* (7.9 per cent.) and possibly *S. serratodentata* and *S. macrocephala* (7.5 per cent.).

The limits of the anterior fin as tested by the ventral ganglion, and the position of greatest width are of some value to the systematist, in individuals well preserved. In *Sagitta ferox*, *S. neglecta*, *S. pulchra*, *S. whartoni*, *S. serratodentata*, *S. siboga*, *S. zetesios*, and *S. planctonis* the fin extends to the ganglion; in *Sagitta enflata*, *S. hexaptera*, and *S. bipunctata* the fin is remote from the ganglion. The remaining species occupy various points between these two extremes. Until the extent of this variation is better known, for each species, separation cannot be rendered any more definite, by this criterion.

The posterior fin is more instructive. The position of greatest width, as tested by the tail septum; the proportion of posterior fin in front of the septum; the proximity of the fin to the vesiculæ seminales, are all serviceable characters. The table shows the grouping of the species in this matter.

The corona ciliata has been considerably used in the past. Length and width in proportion to the total length, shape and location, how much on head, how much on body, — these form the important features. The great difficulty in using this character lies in the fact that it is very rarely present in preserved material. With living material the corona might have considerable significance, but with formalin material nearly all specimens have apparently lost the structure.

The collarette and lateral fields are of some utility. The collarette or neck fin is an expansion of the ectoderm in the region of the neck and appears as a constant specific character. Some species are always provided with it as *Sagitta siboga*, *S. ferox*, *S. neglecta*, *S. regularis*, *S. pulchra*, *S. robusta*, *S. zetesios*, and *S. decipiens*. It is absent in the remaining species. The lateral fields are those areas between the muscles so that, in general, the presence of large lateral fields is co-existent with weak muscles. Species in this category are very often flabby and transparent in formalin. Formalin acts upon the muscles causing opacity and firmness so that the species with strong longitudinal muscles are readily separated from those with weak mus-

cles. The table indicates the distribution of these characters among the species.

Finally the general shape of the animal is of prime importance. Length, breadth, proportional length of tail, extent or absence of a constriction at the tail septum, are all points to be noted. In some species the body tapers gradually from head to tail, in others a sudden diminution occurs at the tail septum; some are of the same width throughout the entire trunk, others are much wider in the middle of the trunk tapering toward head and tail. Matters of this kind, while extremely useful, are difficult of diagnostic description so that camera drawings present the most accurate means of exhibiting these relations.

KEY TO THE GENERA OF CHÆTOGNATHA.

1. Two pairs of lateral fins. Two pairs of rows of teeth. Only slight epidermal thickening on body *Sagitta*.
2. One pair of lateral fins, partly on body and tail. One pair of rows of teeth. Body longer than tail. No epidermal thickening behind the head..... *Krohnia*.
3. One pair of lateral fins, entirely upon the tail segment. Two pairs of rows of teeth. Prominent thickening of epidermis extending from behind head to tail. *Spaaella*.

KEY FOR THE DETERMINATION OF THE SPECIES OF SAGITTA TO BE USED FOR LIVING OR PERFECTLY PRESERVED MATERIAL.

1. Species with collarette.....12.
1. Species without collarette..... 2.
2. Shaft of seizing jaw serrated..... *Sagitta serratodentata*.
2. Shaft of seizing jaw not serrated.....3.
3. Irregular transverse septa present on trunk..... *Sagitta minima*.
3. Irregular transverse septa absent on trunk.....4.
4. Posterior teeth 12 to 32 in number.....5.
4. Posterior teeth 1 to 12 in number.....8.
5. At least 50 per cent. of the posterior fin in front of the septum.....6.
5. Less than 50 per cent. of posterior fin in front of septum..... *Sagitta bedoti*.
6. Tail 28 to 40 per cent. of total length..... *Sagitta macrocephala*.
6. Tail 16 to 25 per cent. of total length.....7.
7. Middle third of body of equal width..... *Sagitta bipunctata*.
7. Body much wider at middle of the length..... *Sagitta enflata*.
8. Length of anterior fin from 44 to 66 per cent. of total length, confluent with the posterior fin. *Sagitta whartoni*.
8. Length of anterior fin less than 40 per cent. of total length, always an interval between anterior and posterior fins.....9.
9. Anterior fin on a level with ventral ganglion..... *Sagitta furcata*.
9. Anterior fin remote from ventral ganglion..... 10.
10. Posterior teeth less than 8 in number *Sagitta hexaptera*.

10. Posterior teeth more than 8 in number11.
11. Middle third of body of equal width*Sagitta bipunctata*.
11. Body much wider at middle of length.....*Sagitta enflata*.
12. Irregular transverse septa present on trunk *Sagitta minima*.
12. Irregular transverse septa absent on trunk13.
13. At least 50 per cent. of posterior fin in front of septum.....14.
13. Less than 50 per cent. of posterior fin in front of septum18.
14. Posterior fin widest in front of septum.....*Sagitta zetesios*.
14. Posterior fin widest at or behind septum15.
15. Posterior fin shorter than anterior fin.....16.
15. Posterior fin as long or longer than anterior fin17.
16. Posterior teeth 9 to 15 in number*Sagitta pulchra*.
16. Posterior teeth 15 to 23 in number*Sagitta siboga*.
17. Anterior fin reaching to middle of ventral ganglion*Sagitta planctonis*.
17. Anterior fin not reaching to ventral ganglion.....*Sagitta decipiens*.
18. Posterior fin shorter than anterior fin*Sagitta ferox*.
18. Posterior fin as long or longer than anterior fin.....19.
19. Corona ciliata extends anteriorly beyond eyes*Sagitta robusta*.
19. Corona ciliata not extending to eyes.....20.
20. Middle third of body of equal width.....*Sagitta neglecta*.
20. Body of equal width from the ventral ganglion to the seminal vesicles.
Sagitta regularis.

If (19) the corona ciliata is absent the following criteria may be used :

19. Middle third of body equally wide.....*Sagitta neglecta*.
19. Body equally wide from ventral ganglion to the seminal vesicles..*Sagitta regularis*.
19. Body equally wide from just behind the neck to immediately in front of the tail septum.....*Sagitta robusta*.

KEY FOR DETERMINATION OF THE SPECIES OF SAGITTA TO BE USED FOR POORLY PRESERVED MATERIAL.

1. Species with collarette.....12.
1. Species without collarette.....2.
2. Shaft of seizing jaws serrated.....*Sagitta serratodentata*.
2. Shaft of seizing jaws not serrated.....3.
3. Irregular transverse septa present on trunk.....*Sagitta minima*.
3. Irregular transverse septa absent.....4.
4. Length of anterior fin from 44 to 66 per cent. of the total length, anterior fin and posterior fins confluent.....*Sagitta whartoni*.
4. Length of anterior fins never as much as 40 per cent. of total length, always an interval between anterior and posterior fin.....5.
5. Tail 16 to 27 per cent. of the total length.....6.
5. Tail 28 to 35 per cent. of total length.....7.
6. Posterior teeth less than 8 in number.....8.
6. Posterior teeth more than 8 in number.....9.
7. Jaws more than 8 in number.....*Sagitta macrocephala*.
7. Jaws less than 8 in number.....*Sagitta bedoti*.
8. Anterior teeth 1 to 4 in number.....*Sagitta hexaptera*.

KEY FOR THE DETERMINATION OF THE SPECIES OF SPADELLA.

1. Average width of collarette nearly half that of the body, widest slightly anterior to the tail septum. Length of fin always less than 5 times its width. Anterior teeth 7 to 10. Posterior teeth 11 to 16.....*Spadella draco*.
2. Average width of collarette much less than half that of the body; widest slightly posterior to the head. Length of fin always more than 5 times its width. Anterior teeth 3 to 5. Posterior teeth 3 to 4.....*Spadella cephaloptera*.

DESCRIPTION OF TABLE.

The data for this table have been gathered from various sources, but mostly from the investigations of Fowler ('05, '06) and Krumbach ('03). In proportional measurements, number of seizing jaws, and number of teeth, the extremes of variation have been indicated wherever possible.

In the case of *Sagitta whartoni* the data have been obtained from Fowler's "Contributions to our Knowledge of the Plankton of the Faroe Channel," 1896. In this instance a considerable discrepancy, due in all probability to a typographical error, is found in comparing the drawing with the descriptive measurements. From Fowler's description the width of the anterior fin varies from 10 to 15 per cent. of the total length; from his drawing it measures but 2.8 per cent. of the total length. Similarly, in the width of the posterior fin, his measurements show variation from 13 to 21 per cent. of the total length, while his drawing shows it but 5.7 per cent. In no other species has the width of the anterior fin been over 6 per cent. of the total length, nor the width of the posterior fin over 7 per cent. For this reason I have utilized the fin measurements as taken from the drawing rather than from the description of *Sagitta whartoni*.

I desire to express my obligations to Dr. C. A. Kofoid, through whose direction, advice, and criticism I have received invaluable aid.

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BIBLIOGRAPHY.

Aida, T.

- '97 The Chætognatha of Misaki Harbor. Annot. Zool. Japon., Vol. 1, pp. 13-21, pl. 3.
 '97 On the Growth of the Ovarian Ovum in the Chætognaths. Annot. Zool. Japon., Vol. 1, pp. 77-81, pl. 4.

Busk, G.

- '56 An Account of the Structure and Relations of Sagitta bipunctata. Quart. Journ. Mic. Soc., Ser. 1, Vol. 4, pp. 14-27.

Cleve, P. T.

- '00 The Seasonal Distribution of Atlantic Plankton Organisms. Göteborgs vetensk. Handl., Vol. 3, No. 2, 368 pp.

Conant, T. S.

- '95 Descriptions of Two New Chætognaths. Johns Hopkins Univ. Circ., Vol. 14, pp. 77-78, pl. 1; also in Ann. Mag. Nat. Hist., Ser. 6, Vol. 16, pp. 288-292, figs. 1-2.
 '96 Notes on the Chætognaths. Johns Hopkins Univ. Circ., Vol. 15, pp. 82-85, figs. 1-5; also in Ann. Mag. Nat. Hist., Ser. 6, Vol. 18, pp. 201-213, figs. 1-5.

Doncaster, L.

- '02 Chætognatha, with a Note on the Variation and Distribution of the Group. Faun. Geog. Mald. Lac. Arch., Vol. 1, pt. 2, pp. 209-218, pl. 13, figs. 39-40.
 '02 On the Development of Sagitta, with Notes on the Anatomy of the Adult. Quart. Journ. Mic. Sci., N. S., Vol. 46, pp. 351-398, pls. 19-21.

Fowler, G. H.

- '96 Contributions to our Knowledge of the Plankton of the Faroe Channel. Proc. Zool. Soc. London, Vol. for 1896, pp. 991-996, pl. 1.
 '05 Chætognatha of the Biscayan Plankton Collected During the Cruise of the "Research." Trans. Linn. Soc. London, Vol. 10, pp. 55-86, pls. 4-7.
 '06 The Chætognatha of the Siboga Expedition. Siboga Expedite, Monograph 21, 86 pp., 3 pls., 6 charts.

Gourret, P.

- '84 Considérations sur La Faune Pélagique du Golfe du Marseille suivies d'une étude anatomique et zoologique de la Spadella marioni. Ann. Mus. Marseille, T. 2, No. 2, 167 pp., 5 pls.

Grassi, G. B.

- '83 I Chaetognati. Faun. u. Flor. d. Golfes v. Neapel, Monographie 5, Leipzig, 1883, 126 pp., 13 Taf.

Hertwig, O.

- '80 Die Chaetognathen, ihre Anatomie, Systematik, und Entwicklungsgeschichte. Eine Monographie, Jena, 111 pp., 6 Taf.; also in Jen. Zeitschr. f. Med. u. Naturwiss., Bd. 14, pp. 196-302, Taf. 9-15.

Kent, W. S.

- '70 On a New Species of Sagitta from the South Pacific. Ann. Mag. Nat. Hist., Ser. 4, Vol. 5, pp. 268-272.

Kowalevski, A.

- '71 Embryologische Studien an Würmern und Arthropoden. Mem. d. Acad. imper. d. Sci. St. Petersburg., Ser. 7, T. 16, 70 pp., 12 pl.

Krumbach, Th.

- '03 Ueber die Greifhaken der Chaetognathen. Zool. Jahrb. Abth. f. Syst., Bd. 18, pp. 579-646, Figs. A-U.

Langerhans, P.

- '78 Das Nervensystem der Chaetognathen. Mb. Ak. Berlin, Jahrg. 1878, pp. 189-193.

Leidy, J.

- '82 Sagitta falcidens. Ann. Mag. Nat. Hist., Ser. 5, Vol. 10, pp. 79-80.

Steinhaus, O.

- '96 Die Verbreitung der Chaetognathen in suedatlantischen und indischen Ozean. Inaug. Diss., Kiel, 49 pp., 1 Taf., 2 Kart.
'00 Die Chaetognathen. Hamburg. Magalhaens Sammelreise., Lief. V. 2, 10 pp.

Stevens, N. M.

- '04 On the Ovogenesis and Spermatogenesis of Sagitta bipunctata. Zool. Jahrb. Abth. f. Anat. u. Ontol., Bd. 18, pp. 227-240, Taf. 20-21.
'05 Further Studies on the Ovogenesis of Sagitta. Zool. Jahrb. Abth. f. Anat. u. Ontol., Bd. 21, pp. 242-252, Taf. 16.

Strödtmann, S.

- '92 Die Systematik der Chaetognathen und die geographische Verbreitung der einzelnen Arten im nordatlantischen Ozean. Inaug. Diss., Kiel., 47 pp., 2 Taf.

Thompson, D. A. W.

- '85 A Bibliography of the Protozoa, Sponges, Coelenterata, and Worms for the Years 1861-1883. Cambridge Univ. Press, 284 pp.

Verrill, A. E.

- '71-2 Report on the Invertebrate Animals of Vineyard Sound and Adjacent Waters. Rept. U. S. Fish Com. for 1871-2, pp. 295-798, pls. 1-38.
'79 Invertebrata of the N. E. Coast of North America. Proc. U. S. Nat. Mus., Vol. 2, pp. 165-205, 227-232.
'83 Results of the Explorations Made by the Steamer "Albatross" off the Northern Coast of the U. S. in the Year 1883. Rept. U. S. Fish Com. for 1883, pp. 503-699, pls. 1-44.

EXPLANATION OF PLATE.

FIG. 1. *Sagitta hexaptera* $\times 2$. *ant.t.*, anterior teeth; *post.t.*, posterior teeth; *s.j.*, seizing jaws; *al.can.*, alimentary canal; *vent.gang.*, ventral ganglion; *ant.f.*, anterior fin; *post.f.*, posterior fin; *t.s.*, tail septum; *t.*, tail; *t.f.*, tail fin.

FIG. 2. *Sagitta neglecta* $\times 2$. *col.*, collarette; *vent.gang.*, ventral ganglion; *ant.f.*, anterior fin; *post.f.*, posterior fin; *t.s.*, tail septum; *t.*, tail; *sem.ves.*, seminal vesicles; *t.f.*, tail fin.

FIG. 3. *Sagitta robusta* $\times 13$. (After Fowler.) *e.*, eye; *cor.cil.*, corona ciliata; *col.*, collarette; *vent.gang.*, ventral ganglion.

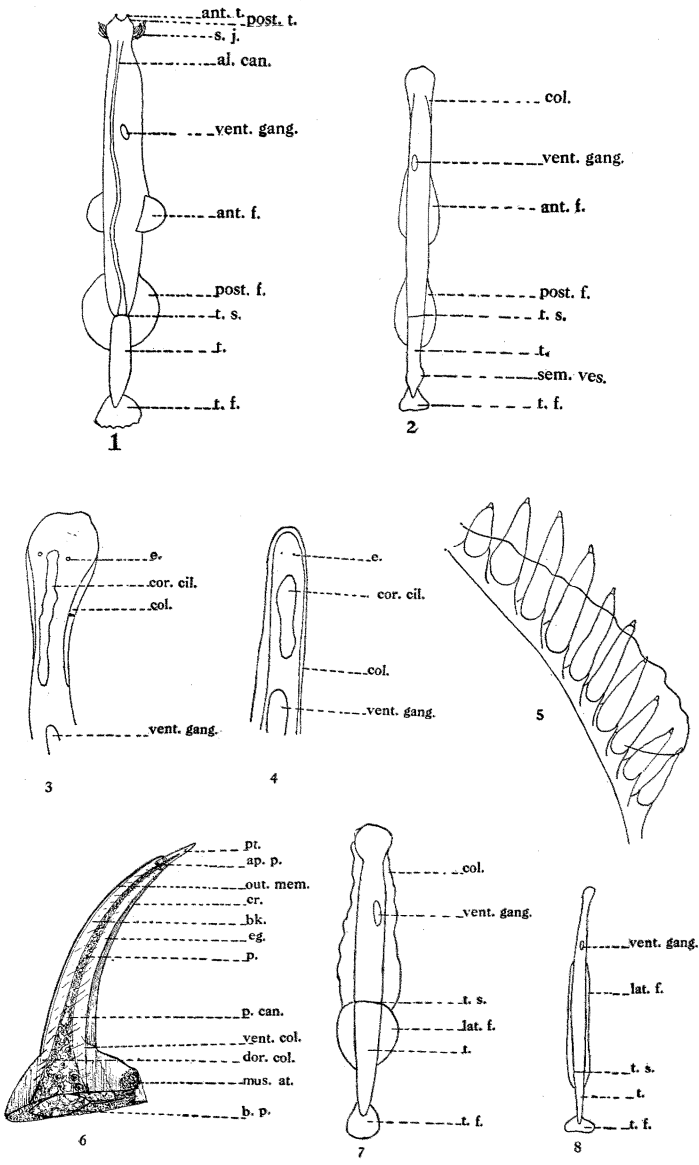
FIG. 4. *Sagitta regularis* $\times 22$. (After Fowler.) *e.*, eye; *cor.cil.*, corona ciliata; *col.*, collarette; *vent.gang.*, ventral ganglion.

FIG. 5. $\times 346$. Vestibular ridge and posterior teeth of *Sagitta neglecta*.

FIG. 6. Typical seizing jaw. (After Krumbach.) *pt.*, point; *ap.p.*, apical pulp; *out.mem.*, outer membrane; *cr.*, crest; *bk.*, back of shaft; *eg.*, edge of shaft; *p.*, pulp; *p.can.*, pulp canal; *vent.col.*, ventral column; *dor.col.*, dorsal column; *mus.at.*, muscle attachment; *b.p.*, basal pulp.

FIG. 7. *Spadella draco* $\times 8$. *col.*, collarette; *vent.gang.*, ventral ganglion; *t.s.*, tail septum; *lat.f.*, lateral fin; *t.*, tail; *t.f.*, tail fin.

FIG. 8. *Krohnia hamata* $\times 3$. (After Fowler.) *vent.gang.*, ventral ganglion; *lat.f.*, lateral fin; *t.s.*, tail septum; *t.*, tail; *t.f.*, tail fin.



Species.	Length in mm.	Width in Per Cent. of Length.	Lat. Field.		Muscle.				Diminution at Septum.			Position of Greatest Width.				Tail Length in Per Cent of Total Length.	Corona Ciliata.			Collarete Present.	Collarete Absent.	General Appearance.			
			Large	Small.	Strong.	Weak.	Broad.	Narrow.	Sudden.	Gradual.	None.	At Center.	Behind Center.	In Front Center.	Evenly Wide.		On Head.	On Body.	On Both.			Opaque.	Transparent.	Firm.	Flaccid.
<i>S. bedoti</i>	105 5	6	×		×			×	×					×		22 30			×		×	×	×	×	
<i>S. inflata</i>	9 29 10	9 10	×			×				×		×				25 26 36	×			×			×		×
<i>S. ferox</i>	10 20	5.8		×	×				×						×	17 26	×			×		×	×	×	
<i>S. hexaptera</i>	15 47	10	×			×	×		×			×				28 40	×		×		×		×	×	
<i>S. macrocephala</i> ..	7 18	7.6		×						×		×				26 40			×		×		×	×	
<i>S. neglecta</i>	5 10	5 6.5		?	×		×			×	?			×		26 40		×		×		×	×	×	
<i>S. bipunctata</i>	9 20	6.3	×		×	×	×			×				×		21 25		×		×		×	×	×	
<i>S. regularis</i>	4 27	6		?	×		×				×				×	28 40		×		×		×	×	×	
<i>S. pulchra</i>	9 22	10.5	×			×			×			?				18 27			×		×		×		×
<i>S. robusta</i>	10 14	4 5.7		×	×					×					×	25 33				×		×	×	×	
<i>S. serratodentata</i> .	5 15	5		×		×	×			×		×				22 36			×		×	×	×	×	
<i>S. zetesios</i>	9 32	6.3	×		×		×			×		×				25 33				×		×	×	×	
<i>S. furcata</i>	12 35	10	×			×	×		×					×		17 25	×			×		×			×
<i>S. siboga</i>	9 20	6.5	×		×		×		×					×		21 33				×		×	×	×	
<i>S. minima</i>	10			?												16.5				×					
<i>S. decipiens</i>	6 12	5								×			×			25 40				×		×	×	×	
<i>S. planctonis</i>	20 30	10 6	×						×			×				25 20	×			×					
<i>S. whartoni</i>	45 11									×		×				26				×					

TABLE OF CHARACTERS.

Concave & Resem.	General Appearance.					Number of Anterior Teeth	Number of Posterior Teeth.	Anterior Fin.							Distance in Per Cent. of Total Length from Anterior to Posterior Fins.	Posterior Fin.										Vestibular					
	Collar-like Absent.	Opaque.	Transparent.	Firm.	Flaccid.			Length in Per Cent. of Total Length	Width in Per Cent. of Total Length.	Extends to Ventral Ganglion.	Remote from Ventral Ganglion.	Approaching Ventral Ganglion.	Widest at Center.	Widest in Front of Center.		Widest Behind Center.	Length in Per Cent. of Total Length.	Width in Per Cent. of Total Length.	Extends to Seminal Vesicle.	Not to Seminal Vesicles.	Longer Than Anterior Fin.	Shorter Than Anterior Fin.	Same as Anterior Fin.	Widest at Tail Septum.	Widest in Front of Tail Septum.	Widest Behind Tail Septum.	More Than 50 Per Cent. in Front of Tail Septum.	Less Than 50 Per Cent. in Front of Tail Septum.	Tooth Row Longer.	Tooth Row Shorter.	Lateral Process Blunt.
×	×	×	×	×	×	9-13	20-32	20	2.4			×		×	5.4	24	4.5	×			×					47					
	×		×		×	7-10	12-17	11-17	1.5 2.8		×		×		6.8	17+	4.5		×		×				66 75				×		
×	×	×		×		6-10	10-14	28-30	4 4.6	×				×	5.7 6.8	23+	4+	×			×			×		40+		×	×		
	×		×		×	1-4	1-6	8.6 13	1.7 2.3		×		?	×	11.1	17+	4.3		×	×		×			51 60			×	×		
		×		×		5-10	14-32	10.7	2.6					×	7.5	16+	3.9	?		×		×			50+		×	×			
×	×	×		×		3-7	9-15	18-21	1.2 2.5	×				×	6.5	23+	4.1	×		×				×		35 45					
	×	×		×		4-7	8-18	15.9	1.5		×			×	7.9	17+	2.7		×	×			×			68 75		×	×		
×	×	×		×		2-4	2-6	13+	1.9			×	×		6.8	23+	2.0	×				×				33+					
			×		×	5-10	9-19	34.6	3.8	×				×	5.7	24-	6.2	×			×			?	64						
	×	×		×		5-10	11-14	20	2.9			×		×	6.8	26-	3.7	×		×				×		35					
×	×	×		×		3-7	8-13	20-24	3.0	×				×	7.5	25	4.4	×		×				×		52			×		
×	×		×			4-9	8-19	22	2.6			×		×	9.5	15	3.0		×		×		?	?	62		×				
		×		×		4-8	5-12	25	2.4			×		×	6.1	20	4.5		×			×			70						
						7-11	13 23	25	1.4 1.8	×				×	15	15	3.2		×						50						
			×	×		3-4	7-8					×																			
×	×					5-10	12-18	11.5	2.5			×			8.5	19	4.9				×	×		?	56			×			
×						5-6	12	19	5	×			×		10	19	6.2			×		×		?	67						
						3-5	5-7	44-66	2.8	?			×		0.0	19-33	5.7					×			40 42		×				

× denotes presence of character.

? possibly present but not observed.

[illegible]